MOUNTAIN LION FIELD GUIDE

HARLEY G. SHAW

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Arizona Game & Fish file photo

INTRODUCTION

The annual mountain lion management reports for Arizona display exasperation on the part of wildlife managers. They need techniques for assessment of lion numbers and of lion depredation problems in their respective units. Estimates of lion numbers in Arizona are based upon general impressions of the district personnel. This manual is intended to synthesize information on lions that might aid wildlife managers in interpreting lion sign and identifying kills in their areas. I hope it aids in refinement of the present gut-level approach.

Many of the statements herein are tentative and are given without citation of references. This is because knowledge of the biology of mountain lions is accumulating rapidly, and much information has not been published. Modifications may be necessary as better data become available. A list of references is included for those who would care to dig deeper into lion biology.

The first section of this manuscript will discuss the present state of knowledge regarding lion behavior as it relates to depredation problems, and to potential census techniques.

The second section will describe lion sign, killing behavior, and other types of physical evidence surrounding lion kills. It will outline methods for documenting and classifying evidence of depredation, and will discuss options open to the wildlife manager for dealing with the problem.

A final section will present a crude approach to counting lions.

INTRODUCTION TO SECOND PRINTING

This field guide was first printed in December, 1979. It was out of print within a year, but requests for it continued to arrive. Reaction to the first edition was generally favorable, but some suggestions were made regarding improvements or additions that would make the guide more useful. I've tried to incorporate these suggestions into the current revision.

In addition to the text of the initial field guide, a chapter on capturing and handling lions has been added. A section giving crude aging techniques is also included. In anticipation of this need to add information as it becomes available, we have decided to print the second edition in a smaller format and punch it for loose-leaf binders. Our hope is to provide a working, growing manual for the management of the species in Arizona.

With this in mind, please note that this guide is not intended as a rigid statement of the way things should be done. We know too little of most species to manage by policy. If possible, I'd like to give the wildlife manager the most current information, so that he can devise an approach to lion management that suits the special needs of his individual unit.

BIOLOGICAL CONSIDERATIONS

Classes of Lions

In discussing lion activity or numbers in an area, one must define the lions being considered. Current studies suggest the following classes in a given lion population.

Resident lions are adult males and females that use established home areas and are reproductively active. Depending upon climate, residents may use the same home area year-round, or they may shift elevationally with seasons. Winter and summer ranges of lions bordered upon each other in Idaho. On the Spider-Cross U study area near Prescott, Arizona, no seasonal changes in home areas occurred. Mature males and females apparently associate with each other only at time of breeding. They occasionally share kills, but circumstances under which this occurs are not yet clear.

Home areas for mature male lions in Idaho ranged from 142 km^2 (55 mi^2) to 293 km^2 (112 mi^2) (Seidensticker, et al. 1973). Home areas for mature males on the Spider-Cross U study area in Arizona ranged from 124 km^2 (50 mi^2) to 162 km^2 (63 mi^2). Home area derivations for males in the Arizona study area, however, were based upon a relatively small number of radio-locations. An increased sample would probably have yielded home area estimates nearer to 390 km^2 (150 mi^2). I suspect that home areas of males of 648 km^2 (250 mi^2) are common in this chaparral type. Home areas of resident males over-lapped, but mature male lions were not found traveling together in either the Idaho or Arizona studies.

Home areas for mature females in Idaho ranged from 31 km^2 (12 mi^2) to 207 km^2 (80 mi^2). In Arizona home areas ranged from 25 km^2 (10 mi^2) to 176 km^2 (68 mi^2) and over-lapped. Females with kittens have been found associated with other mature females with kittens or with other single mature females.

Immature lions are defined as offspring of resident adults that are still traveling with, or close to, the mother. For the first year they are doing little of their own killing and are dependent upon the mother for food. By the middle of the second year of age, they may begin to show some independence and by the end of the second year will be separated from the mother. Litter mates of both sexes may travel together for a while after leaving their mother.

Transient lions are those in the 1.5 to 3 year age class searching for a home area. Very old lions may also become displaced wanderers. Such transients may move into an area and stay for a few days, then move on. The percentage of animals of this class in an area may vary with the rate of mortality of established residents. In a stable, unharvested lion population where all home areas are filled, few transients will be present. Where turnover of lions is rapid, more transients will probably occur.

Depredation Behavior

Much still remains to be learned about lion depredation patterns. Research in various states over the past 15 years has indicated that considerable variation occurs in the species of prey taken by lions throughout the West. Kill data gathered in one area do not necessarily apply to another. Data gathered during one period of time may not apply even to the same area 10 years later. Studies of food habits of lions are covered in various references listed at the end of this report. They are worth reading, but individual area managers must ultimately decide which data best fit their particular situation, or whether any fit at all.

Problem lion depredations usually involve lion killing of cattle and sheep. Perhaps less of a problem, from the public relations standpoint, is the killing of wild ungulates by lions. Situations may arise, however, where an area manager may be prompted to recommend lion control to increase a desirable wild ungulate. In light of current public attitudes such programs will be increasingly difficult to sell, even where they might be effective.

Lion Predation on Cattle. Cattle losses to lions appear to be greater in Arizona, New Mexico, and Texas than in

states further north. The degree of lion depredations on cattle seems to relate to types of cattle management in a given area and to the relative abundance of other prey species. Losses are greatest where calves are born in lion habitat, especially if deer densities are relatively low.

A high proportion of cattle kills are calves (Figure 1). In our Arizona study, 93 percent of cattle kills found were less than a year old, although mature cows up to 800 pounds were taken. Nevada reported that of 32 cattle kills investigated, all but two were calves. To date, I know of no substantiated reports of lions taking mature bulls. Size of prey seems to be important, although behavior, such as playing by calves, may trigger lion attacks. In general, one should be skeptical of reports of lions killing cattle when the prey size is beyond 300-400 pounds.

Cattle kills by lions usually involve single calves or yearlings and kills are usually covered. A lion may return to feed on such a kill for 3 or 4 nights. They normally uncover the kill at each feeding and move it from 10 to 25 yards, then re-cover it. It may be left uncovered after the last feeding, hence a search made over an area of 50-100 yards surrounding a suspected lion kill may reveal earlier burial sites.

Lion Predation on Domestic Sheep. Lions kill sheep primarily in the summer. Sheep are usually pastured away from lion country in winter, although lions occasionally invade pastures in settled areas. All age classes of sheep are taken, but lambs seem to be preferred when available. This may be due to the active behavior of lambs triggering lion attacks.

A single lion may kill as many as 15 to 20 sheep on a single bedground in one night. Five to 10 at a single killing are common. Generally only one or two will be eaten. The lion may then return for several nights to feed and often will kill additional sheep on return visits. Most of the dead sheep will not be covered, although the particular sheep eaten may be carried or dragged for some distance and then buried.

Lion Predation on Horses. Horse losses to lions are now relatively rare. Lions were reputed to prefer horse meat in days when range colt operations existed. In

Figure 1 Whitefaced calf killed by mature female lion. Note efforts to cover kill even in absence of debris. *photograph by Harley G. Shaw*

general, colts are now raised away from lion habitat. Occasional attacks are still reported by ranches pasturing horses, particularly colts, near wilderness areas. Size seems to be the determining factor, with small colts being the most common target.

Lion Predation on Deer. Deer are the staple of lions throughout North America. Deer kills usually occur in singles. Two or even three kills may be found close together, however, especially if a female lion with cubs is involved. Deer are usually covered after the first feeding, then uncovered, fed upon, moved a short distance, and re-covered (*Figure 2*). Three or four feedings on a single kill are common. All ages of deer are taken. Fawns seem to be selected during the immediate post-fawning period, bucks are selected during the rut and immediately after fall hunts. Does, fawns, and bucks appear to be taken approximately in proportion to their occurrence in the deer herd during late winter and spring.

Lion Predation on Elk. Elk are relatively common prey of lions. In general, lions prefer calves and avoid mature bulls, although they have been known to take all age classes of elk. Elk kills are similar to deer kills in that they usually occur singly and are usually covered and revisited. In colder climates, a single elk kill may be fed upon for a week or more.

Lion Predation on Bighorn Sheep, Pronghorn, and Peccary. Kills of bighorns and antelope have been documented but are relatively rare. They follow the form, generally, of deer kills. Based on limited data from the Three Bar Wildlife Area in east central Arizona, kills of javelina are common. The impact of lions on javelina populations, however, is unknown.

Lion Predation on Smaller Prey. Most of the larger rabbit and rodent species are taken by lions at times. Dependence of lions on these species, however, has not been found in studies to date. Idaho workers felt that lions fed on ground squirrels during summer months thereby decreasing their use of big game species. Beaver are important in lion diets in some areas. Heavy use of lagomorphs occurred on the North Kaibab after a decline in deer numbers. The lion population seemed to be stressed during this period.

Figure 2 Typical deer kill site. Kills are frequently dragged under trees and covered.

photograph by Harley G. Shaw

Attacks on small domestic prey, such as chickens or turkeys, have been documented. These are usually rare and seldom become a continuing problem. Cases of attacks on domestic dogs have also been recorded.

In areas of high densities, subdominant lions may be forced to live away from the ranges of primary prey species. At such times, they may more commonly feed on rabbits, rodents, or small domestic species. It is interesting to note that younger lions seem to figure strongly in recorded attacks on humans and pets, thus unusual depredations may involve young, sub-adult lions looking for a place to live.

In general, the further the animal killed deviates from "deer size," the more skeptical one may be of it being a lion kill. Understanding the types of prey available in an area, the forms of livestock operations, and special habits of lions in a given area are important. This type of knowledge overrides broad generalizations derived from lion studies made elsewhere.

READING THE SIGN

Telling someone how to read sign is like telling someone how to play the piano. The only way to learn is to be shown and to practice. Experience is essential. The best sources of information for district personnel are experienced lion hunters. Anyone interested in developing skills in seeing lion tracks and in finding lion kills can benefit by spending time with such people.

It is difficult to write about sign made by a single species. To be meaningful, all the various tracks and marks that might be mistaken for lion sign must also be discussed. This paper is not intended to be a treatise on tracking. It should be supplemented by such tools as *Field Guide to Animal Tracks* (Murie 1954) and *Methods of Investigating Predation of Domestic Livestock* (Roy and Dorrance 1976).

Tracks. The domestic dog is the only animal that occurs commonly in Arizona and leaves tracks the size of adult lions (*Figure 3*). The size and shape of coyote tracks make them reasonably easy to distinguish from lions. Wolves and jaguar are so rare in Arizona as to be beyond serious consideration. Tracks of larger dogs,

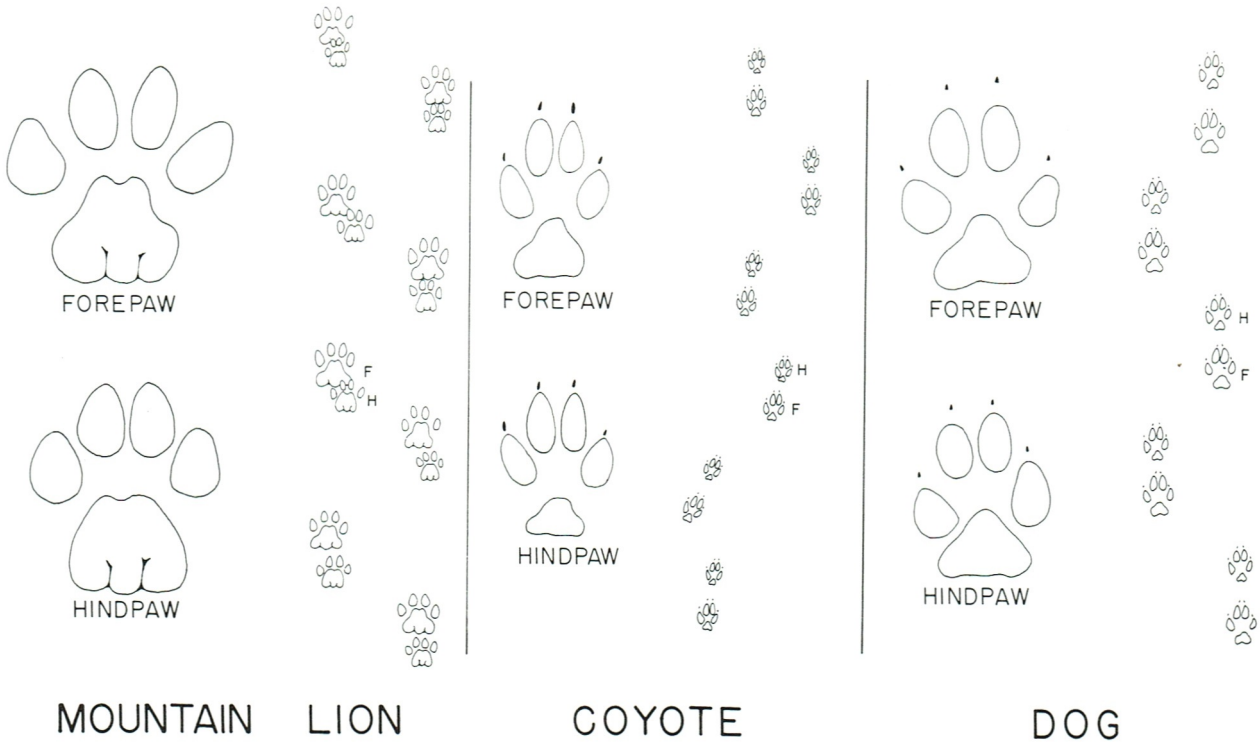


Figure 3 Comparison of lion, dog, and coyote tracks. Note that due to variations of track sizes within species, these tracks are not necessarily to scale.

however, match lion tracks in size and approximate their shape.

Size and shape of the heel pad is the best characteristic to use in distinguishing lion tracks from those of large dogs (*Figure 4*). The heel pad is more easily seen than toes on a variety of ground surfaces, and it leaves more easily distinguishable markings. Experienced hunters can often identify a lion track if only a small portion of the heel pad shows. Most diagnostic are the three distinct lobes in the rear of the heel. The lion leaves a much broader and flatter heel print relative to the overall size of the track than do dogs. Dogs generally dig into the ground surface deeper than do lions.

Compared to lions, dogs are sloppy travelers. Unless closely pursued or pursuing prey, lions sledom move faster than a walk. They put their feet down firmly, leaving no disturbance outside the track. They leave drag marks between tracks only in relatively deep snow. When moving over level terrain in a straight line, rear feet of lions will register partially or totally with front tracks, hence the hind print is the more commonly seen. In contrast, canids often travel at an easy trot. They stir up dirt and gravel around their tracks. They frequently move with their bodies at an angle to the line of travel, so that hind and fore tracks do not always overlap.

Claw marks on the dogs are not totally diagnostic. Some dogs can travel on hard ground without showing distinct claw marks, while a lion moving fast will often show claws. The heel shape and relative "cleanness" of the track seem to be better characteristics than presence or absence of claws.

Other Sign. Other sign made by lions includes scratches (*Figure 5*), dung heaps, and mounds. Scratches are made by mature males and seem to serve a quasi-territorial function. They occur along rims, in saddles, and along major drainages used as traveling routes by lions. They are usually made under large trees near a rim or drainage. They seem to occur in greatest densities where the ranges of two or more large males overlap.

Dung heaps are made by both sexes. They merely represent a site where fecal material has been buried.

Figure 4 Lion track in dust. Width of heel is most useful measurement in comparing tracks. Measurement here is in centimeters.

Figure 5 Typical scratch made by male lion. Leather pouch is approximately 4 x 5 inches.

These occur frequently near kills and may be used as an aid in locating kills. Droppings may be left at sites other than kills.

Mounds are apparently made by females. I have seen only two or these in 8 years, and have photos of neither. They are relatively rare and may be related to birth or presence of young litters. They are large, piled mounds, 4 or 5 feet in diameter, consisting of pine needles or other debris. They look, at a distance, much like a buried kill, but contain no animal residue.

KILLS

Kill Location. Most of the lion kills inspected by wildlife managers will be reported by other people, such as ranchers, or found incidental to other field work. Detailed documentation of kills made by lions in a given area is time-consuming and probably cannot be done without the help of trained lion dogs and experienced lion hunters, or radio-marked lions or prey species.

As is the case with any assessment of mortality, the sooner a kill can be viewed, the easier it is to determine the cause of death. If a lion kill can be investigated with 2 or 3 days after the kill occurs, cause of death can usually be assigned with fair accuracy. The task becomes increasingly difficult after this length of time.

As a rule, if the involvement of a lion in a kill can be positively demonstrated, it is likely the lion actually did the killing. However, lions have been known to feed on meat that they did not kill and to cover carrion. These instances are apparently rare.

If a carcass can be inspected before it is fully consumed, the neck area should be dissected (*Figure 6*). Lions usually kill by biting the back of the neck, although they may also suffocate the animal by biting the throat (*Figure 7*). Kills usually display massive hemorrhage on the back of the neck and near the base of the skull. Claw marks and rakes along the shoulders, made on the back of the prey, are also good indicators.

Blood stains on the ground at the kill site are evidence that the animal was actually killed by a predator.

Kills made by domestic dogs normally show damage to the hind quarters of the prey, and usually display

Figure 6 Tooth marks on throat of deer killed by mature female lion.

Figure 7 Tooth marks on throat of deer killed by two sub-yearling lions.

evidence of much chewing and harassment prior to killing. Both lions and coyotes are usually fairly efficient killers.

The distance between tooth marks or holes on the hide should be measured if possible. Canine holes from a single bite from a mature lion will range from 4.5 to 5.0 cm apart for top canines, and from 3.0 to 4.0 cm apart for bottom canines. Coyote bites will be smaller.

The lion is the only commonly occurring predator in Arizona that covers its prey. Grizzly bears are also known to cover kills, so this characteristic alone will not suffice in states with grizzlies. The fact that a kill is not covered does not eliminate it as a lion kill, however. Deer or calf kills are occasionally left uncovered. Where mass kills of prey occur, as in sheep bedgrounds, none or perhaps only one or two of the carcasses will be covered. Normally, however, even where deer or calves are killed on bare ground, unsuccessful efforts to cover the kill, as witnessed by much scratching and scraping, will be made. More often than not, a deer or calf killed in open habitat will be dragged back under a low-hanging tree or bush and buried. If the kill is more than one day old, more than one burial site will usually be present with drag marks evident between burials. Generally, the paunch will be buried at the site of the first feeding.

After the animal is killed, lions generally enter the carcass just behind the rib cage, sometimes actually breaking off ribs. They apparently eviscerate the carcass, then feed on the liver, lungs, and heart. They seldom, if ever, feed on the paunch. The larger leg muscles are normally consumed next, generally from the underside of the legs rather than the outside. Older kittens feeding on a kill will often eat all of the meat and most of the bones. Single adults may leave a kill before it is fully consumed.

Certain signs do exist in the vicinity of kills. An observer with an awareness of these can locate more kills during other routine work. Large quantities of lion sign in a limited area often indicate presence of a kill. Lion tracks going both ways on what appears to be a "lion path" are good indicators that a kill is near. A lion may bed several hundred yards from a kill and go back and forth to it several times. Trailing up one of these

"paths" in both directions will often disclose the kill. An abundance of lion scratches and, particularly, dung heaps are good indicators of a kill. Above all, anywhere lion sign suddenly gets abundant the presence of a kill is likely.

Kills are usually hidden under trees, particularly large, low, overhanging junipers or pinyons. Large ponderosa pines will also be used. Lions often drag kills to a tree where adequate debris for covering them is available. Where good trees are not available, the thickest clump of brush may be used. Drag marks between burial sites are good aids in finding kills (*Figure 9*). If solid documentation of a kill is needed, a camera is by far the best tool. This, coupled with a checklist to insure the appropriate kill characteristics have been noted, is most helpful. A suggested form is included with this report. Photos should include tracks at the kill, the covered kill before it is disturbed (*Figure 10*), drag marks, other burial sites, and the actual kill site, especially if blood stains are present on the ground. External and internal signs of injury on the carcass are also important (*Figure 8*). Color transparencies using fairly fast film for work in low light are best (*Extachrome 400*).

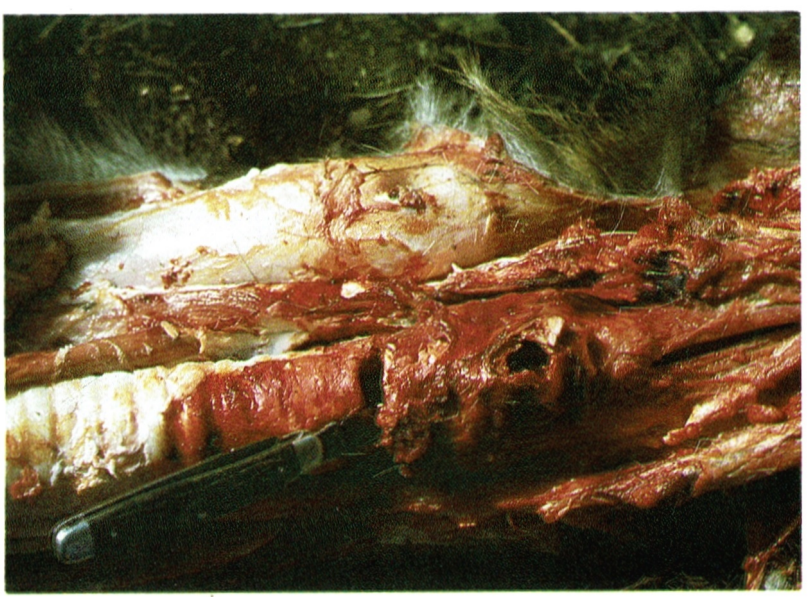


Figure 8 Throat area of lion-killed elk dissected out. Holes are tooth-marks in wind-pipe.

Figure 9 Drag marks where lion moved carcass of a mule deer doe.

Figure 10 Lion-killed mule deer covered in typical fashion.

photograph by Don J. Neff

Notes on size, age, and physical condition of the prey animal may also be important. Note particularly the amount of fat around the mesenteries and the flesh. Note the color and consistency of the femur marrow. If it is reddish and of low viscosity it may indicate the prey was in poor physical condition. Look the skeleton over for signs of old fractures. If they are still present, check the lungs for color. Normal lungs are pink; diseased ones are usually darker. Lions are not strongly selective for diseased or crippled animals, but will, in some cases, take animals that might have died shortly for other reasons. When a tally of kills in an area is being made, such "pseudo-predation" should certainly be differentiated from true predation if possible.

ESTIMATING LION POPULATION CHARACTERISTICS

Field Census. The only technique used successfully to estimate lion numbers has been the capture-recapture method. For most district personnel, use of this method is not practical although at least one district conservation officer in Idaho carried out a lion marking program in his unit. Montana has experimented with use of guides and houndsmen during off seasons to mark lions. Reports of the success of either of these programs are not yet available.

From a more practical standpoint, track counts and track measurements are probably the only feasible means of evaluating lion numbers on a broad scale. Much remains to be learned regarding the use of this technique; its usefulness will probably vary from area to area depending upon ground conditions. The following discussion is an effort to give district personnel at least the rudiments of a tool for evaluating lion sign they find in their districts.

Width of heel pads on both front and rear tracks appear to be the most useful measurements to be taken. Front tracks are larger and rounder than the rear ones. Tracks of rear feet will occur superimposed on front tracks or will lie just in front of the front track where the lion has over-stepped. They may be more difficult to see due to the fact that hind tracks will often partially or totally cover them. Care should be taken in measuring tracks to be certain that only a single track is being

measured rather than a composite of two superimposed tracks. Inspection of a long line of tracks may be necessary before all needed measurements can be taken. This can be confounded where more than one lion, such as a female with advanced young, is involved.

Tracks of grown, mature males can be identified with a fair degree of certainty by experienced observers. Uncertainty increases in other sex and age classes. Feet of lions apparently continue to grow until the animals are 3 to 4 years of age. Males grow much more rapidly than females. Young males will therefore leave tracks approaching the same size of those of mature females. Size differential develops fairly early, hence tracks of male kittens and female kittens within a litter can often be distinguished if the tracks occur together.

The average weight for a given age or sex class varies from area to area. As a result, lion track measurement criteria developed in one area may not apply to another. Criteria developed by Koford in California are similar to those found in Arizona. Lions on the North Kaibab are decidedly larger and leave larger tracks than lions in central or southern Arizona. While criteria developed on the Spider-Cross U study area (*Table 1*) should apply reasonably well for most of Arizona south of the Colorado River, district wildlife managers would do well to measure feet of lions taken by hunters in their own units whenever the opportunity arises, thereby developing criteria of their own. *Table 2* presents possible track combinations to be found, based upon current knowledge of lion behavior, and a rough guide for interpreting these combinations. Use of *Tables 1* and *2* together should aid in developing some insight into population composition in their units. Efforts are being made to develop more objective methods of distinguishing tracks of advanced young lions from those of mature females. I hope eventually to refine the information presented here.

Converting track data to actual lion numbers is a risky procedure at best. It is, however, about all we have to offer at this time. Koford, using established routes along roads in California, developed indices which he felt converted individual lion tracks per 100 mi. His method, however, yielded density estimates lower than those developed by the California Fish & Game

TABLE 1

Heel pad measurements (mm.) from various study areas in Arizona and California.

	LOCATION					
	California		Central Ariz.		N. Kaibab, Ariz.	
Age Class	Hind	Fore	Hind	Fore	Hind	Fore
Mature male	49-63	nm	51-56	57-67	53-60	68-75
Mature female	43-48	nm	41-51	51-57	45-60	55-65
Transient male	nm	nm	nm	nm	48-55	54-60
Transient female	nm	nm	nm	nm	45	50
Kittens	35	nm	nm	nm	22	27

nm = no measurements

Department during intensive radio-tracking studies. In addition to this, his approach required long blocks of time. This would limit its usefulness for most district wildlife managers.

Dusty roads are the best places to measure lion tracks. They can be spotted from the cab or pickup by an experienced observer, although a second observer riding on the hood increases chances of seeing tracks. Lions tend to follow roads in their wanderings, hence leave fairly long lines of tracks for measurement. For Arizona, the dry May-June or early fall periods when roads have been beaten into dust by traffic are the best times for surveys. Muddy roads or mud around stock tanks also provide reasonably good track-measurement strata. Measurement of tracks in snow is usually more difficult, although fresh, wet snow will hold an impression sharp enough for measurement. Some variation in track size will occur depending upon tracking strata. A degree of interpretation, in addition to track measurement, will be required of the observer when classifying tracks on different strata.

A possible procedure is as follows:

1. Develop the habit of watching for lion tracks whenever tracking conditions are suitable.

2. Measure pad width (*Figure 4*) on both front and rear pads.

TABLE 2

Potential track combinations and interpretations.

TRACKS OBSERVED	INTERPRETATIONS	COMMENTS
SINGLE LION:		
Front pad, > 57mm	Mature male.	Scratches associated
Front pad, 40-57mm	Mature female or male transient male or female.	with tracks suggest female Young lions will have tighter elongated track.
TWO LIONS:		
One with front pad > 57mm other with front pad 40-57mm	Mature male and breeding female.	This type of association usually lasts less than 10 days.
Both with front pads 40-57mm range	Mature female with advanced young or newly independent litter-mates together.	
One with front pad 40-57mm; other smaller.	Mature female with single young or recent independent litter-mates, one male, one female, still together.	
THREE OR MORE LIONS:		
	Almost invariable female with litter. Many find another mature female with such litters, or an advanced young with smaller litters on rare occasions. Tracks with pads under 40mm are young lions; track of mature female should be near by. Cat track under 35mm and traveling alone is probably bobcat.	

3. Classify the lion to the best of your ability using criteria presented in the Tables 1 and 2 and any other evidence you might be able to observe (*e.g., toms only leave scratches; it is unlikely that mature toms and kittens will be found together, etc.*).

a. Tracks of mature males undoubtedly represent resident lions. They can be considered as established and living in the area.

b. Tracks of females with kittens can be considered established residents.

c. Tracks that might be either single mature females or young subadult males are more difficult to distinguish. Perhaps only half of such "doubtful" tracks can be considered as established residents in estimating the population composition. All of these tracks can be counted, however, in the population tally on the assumption that new-coming transients will balance those leaving.

d. Tracks too small to be mature females, but traveling singly, are probably young transient females. They, too can be counted in the population but must be counted as transient in estimating the composition.

e. The location of all tracks judged to be resident males or females can be plotted on a map of the area. Those that can be distinguished by measurements alone can be considered distinct lions. Where tracks measured in different portions of an area are quite similar in size, a measure of distance between their locations can be used to decide if they were likely to have been made by the same lion. Based upon diameters of home areas determined in the various radio-tracking studies to date, male lion tracks found more than 15 airline miles apart, regardless of similarity in size, can probably be considered different lions. Mature females found more than 9 miles apart can be considered distinct. Obviously, exceptions to the above exist. We know little, for example, of the movements of lions between the insular mountain ranges in southern Arizona. The present approach is presented as a temporary rule of thumb until

better data or better techniques are available.

f. Keep in mind that the above measurements apply only if used within a given season. In much of Arizona, movements of lions between winter and summer range will occur. In chaparral habitats and below, the above distances probably apply to tracks found year-round. No seasonal movements, for example, occurred on the Spider-Cross U study area.

g. The above distances have little meaning for tracks judged to be made by young, transient lions. Such tracks should be attributed to the same lion, if close in size, regardless of where they are found within the unit.

h. This approach is geared, obviously, to yield a minimum estimate of lion populations since few observers will have the time to locate tracks of all lions in an area. Also, use of the geographical distances recommended will probably lead to under-estimation of populations rather than over-estimation since it assumes little or no overlap in lion home areas.

This procedure sounds rather involved, and it would be if one were dealing with a high-density species. With lions, the actual number of tracks found over a given season will be fairly small.

Age Determination

Age data are probably one of the most convenient forms of information to be gathered from lions taken by hunters in Arizona. Monitoring of lion harvest data is our only real means of assessing the condition of our statewide lion population.

While lion harvest numbers may give us an estimate of long-term lion population trends, they are relatively insensitive to annual changes and tell us little about other characteristics of the population. Trends in sex and age structure of the harvest may give us insights into other facets of various lion populations, thereby affecting management decisions in the future.

Questions age data answer include:

1. Is the age or sex structure of the statewide

lion harvest changing? A strong shift to younger age classes could mean that the resident adult base of the population is being overharvested. A decline in lion numbers could be expected to follow.

2. Do various forms of hunting take different segments of the population? The limited evidence available suggest that dog hunters harvest mature males out of proportion to their occurrence in the population. Dog hunters have the opportunity to decide whether or not to trail a particular lion and to accept or reject the lion after it is treed. Harvest by the opportunist segment of the lion hunters seem to be weighted toward young female lions. Better information is needed regarding these phenomena. It might modify lion hunt regulations in the future. Cessation of lion hunting during deer, elk, and javelina seasons, for example, might reduce the hunter impact on a lion population more effectively than would a season shortened in a non-discriminatory manner.

3. Do some portions of the state support only a transient population of lions? The current theory of lion social behavior holds that young, resident lions and old deposed lions range widely seeking new home areas. Areas with marginal, low-density populations may be composed largely of these transients — lions unable to compete for home areas in better habitat. Information on this phenomenon could be critical to lion management in the state in that these marginal and seldom-hunted habitats may not hold viable, productive lion populations and may depend upon producer populations in better habitats. If this is true, such areas could not be depended upon as reservoir population to buffer declines in the statewide population.

Unfortunately, no method has yet been developed for accurate age determination of lions. Various techniques are being assessed by workers in Nevada and Montana and may soon be available. For the present, however, subjective assessments by experienced field workers are the best tools available.

Several characteristics are available which will give a

field man clues to an animal's age. Track (or pad) measurements and family group characteristics have already been discussed in the section on reading sign. Questioning of the successful hunter regarding presence or absence of other lions at the kill site may give insight into the age of the animal killed. Groups of 2 to 3 lions, for example, almost always indicate females with kittens or, rarely, a breeding pair.

Pelage coloration may give a clue to the age of the animal. Spots of kittens, of course, are obvious. Faint spotting may be retained in the underfur, however, until the animal is nearly a year old. Observation of a lion under different light conditions and at different angles may disclose such residual spotting (*Figure 11*). Faint striping, also a residual aspect of kitten spots, may be retained until the animal is 3-4 years old. Tiny, undeveloped nipples on females that otherwise appear mature indicate an animal that is probably under 3 years.

Tooth replacement patterns can be used to determine kitten age through 1 year (*Figure 12*). Tooth wear, (particularly the shoulder on the upper canines) and coloring give clues to relative age of adult lions (*Figures 13-15, table 3*).

With our present state of knowledge, only relative ages can be assigned. With a little experience, however, observers can place lions into 5 categories with reasonable accuracy: kittens (under 6 months); yearlings (6-18 months); young mature (18 months - 3 years); mature-prime (3-8 years); and old (over 8 years). Table 4 summarizes the various characteristics by age class.

TABLE 3
Age class characteristics for Arizona mountain lions.

Age Class	Coloration	Dentition
1	Spots distinct to 3-4 mo. fading afterward. Usually visible in underfur through 6-mo. Striping inside front leg distinct.	See *Table 4*
2	Spots faded entirely or faintly visible in underfur. Striping inside front legs present, but extremely faint by 10 mo.	See *Table 4* for lions under 1 year. Full mouth by 1 year; Canine, cementum ridge barely visible if at all.
3	Spots entirely gone. Striping inside front legs very faint or absent.	Canine cementum ridge 3-5mm from skull line. Teeth white to faintly yellow.
4	Striping inside front legs absent.	Canine cementum ridge 6-7mm from skull line. Teeth yellowing. Increasing wear apparent on canines and incisors.
5	No obvious change	Canine cementum ridge 8-10mm from skull line. Teeth very yellow. Canines worn blunt.

Age Class Definitions:

1. Kittens - under 6 mo.
2. Yearlings - 6 mo. to 18 mo.
3. Young - mature (transient) 18 mo. - 3 yr.
4. Mature - prime 3 yr to 8 yr.
5. Old - over 8.

**** Cementum ridge measurements are for upper canines. Measurements are from center of ridge to skull on outward-facing side of tooth. (Figs 12)***

photograph by Gerald Blair

Figure 11 10-month-old female lion showing spotting under adult pelage.

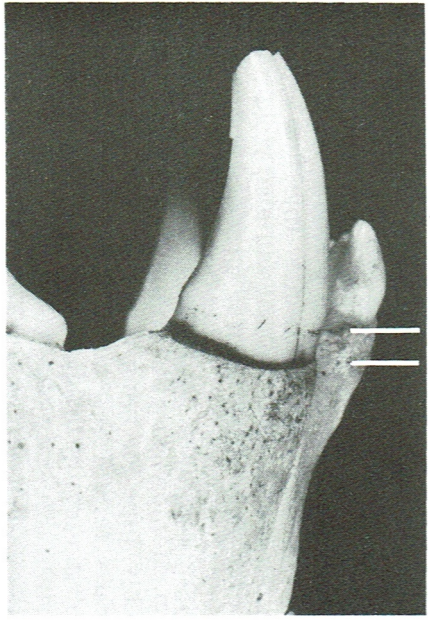
TABLE 4

A guide for estimating ages of mountain lion kittens by tooth eruption sequences.

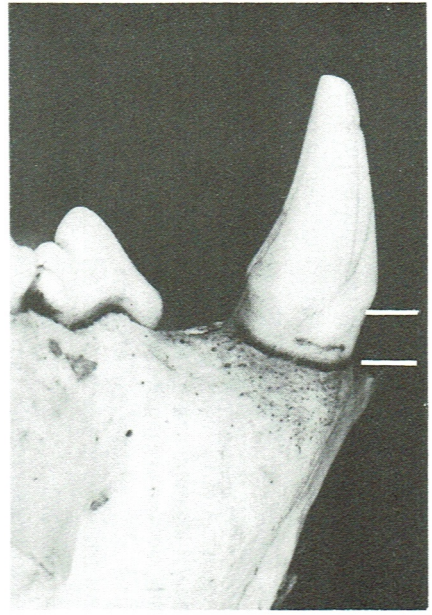
(Nevada Dept. of Wildlife 1983)

Age (months)	Sequence of permanent tooth eruption
2	Complete set of deciduous teeth; permanent P^2 and M^1 erupted
3	Permanent incisors erupted
4	Upper canines and P^4 erupt
5	M_1 and lower canines erupt
6	P^3 erupts
7	P_4 erupts
8	Upper canines 50-60% extended from gum lines (males: 16-18mm, females: 12-14mm)
9 & 10	P^4, M_1 and P^3 become fully extended
11 & 12	P_4 and P_3 fully extended; upper canine 70-80% extended (males: 20-22mm, females: 15-17mm)
13 & 14	Upper canines 80-90% extended (males: 24-27mm, females: 19-21mm)
15 & 16	Upper canines fully extended by 16th month (males: 28-31mm, females: 23-25mm)

Upper canine of 18 mo. to 2-year-old lion.



Upper canine of 3 - 5-year-old lion.



Upper canine of 8 + year-old lion.

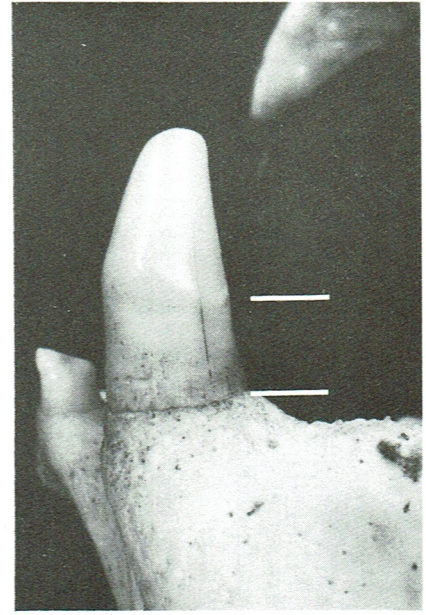


Figure 12

photograph by Gerald Blair

CAPTURING AND HANDLING LIONS

Lions occasionally turn up in strange places and must be moved. However, they do not do so often enough to allow the wildlife manager or regional specialist to become experienced in capturing lions. While dosages for drugs are accessible, the more practical aspects of capturing and handling lions are seldom described in the literature.

Table 5 gives dosages for Ketamine as presented in the *Animal Restraint Workbook* (Jessup, et al. 1980). Sernylan is best for lions, but may not be immediately available. When Sernylan is used in concentrations of 100mg/cc, 1/2cc is ample to immobilize mature females; 3/4cc will handle mature males. Dosage should be reduced for half-grown kittens. Ketamine is normally stocked by veterinarians. Ketamine, however, requires a much larger dart (3-4cc) than Sernylan (1cc) to hold the large volume of drug needed to attain immobilization.

TABLE 5

Doses for Ketamine

Estimated Weight lbs	Mg Ketamine Needed at 3 mg/lb	Volume in ml or cc	Delivery System
80	240	2.4	3cc dart or small extension syringe
90	270	2.7	
100	300	3.0	
120	360	3.6	4 or 5 cc dart
140	420	4.2	
160	480	4.8	

Drug should be administered, if possible, in the large foreshoulder or hindquarter muscles. Injection by hand syringe into a foot or into the tail will also yield immobilization and can at times be used on caged animals.

Other than the dart equipment, materials needed include ropes for lowering the animal and smaller ropes, or preferably, tape for tying the legs. Large adhesive tape or duct tape work much better than rope in restraining the feet of drugged cats. For lowering the animal from a tree, any rope strong enough will do. A lariat is adequate; nylon rope 1/4" or better in diameter

is also good. Extremely small rope, even though strong enough, will be hard to handle and to get on the animal. Rope 3/8-1/2" in diameter is easiest to handle.

Time required to tranquilize the animal after injection varies greatly with injection site, mental state of animal, size of animal, etc. With fresh Sernylan, a lion may be manageable within 4-5 minutes. Under less ideal conditions, 20-30 minutes may elapse before the animal can be handled. Signs to watch for include slobbering, unsteadiness of head and body, and a wide-eyed expression. If the cat is approached before it shows these signs, it may jump the tree or retreat to a more remote site. Do not push the animal until signs of drug reaction are definitely seen. If no reaction is seen within 30 minutes, a second full injection should be given.

On initial approach, use a 4-5 foot stick to prod the cat gently. If a paw can be touched without response, the lion can probably be handled. One should be able to stroke the cat's muzzle with the stick without producing a snarling or biting reflex.

Once the animal reaches this point, only a few minutes are available before it goes under far enough to fall. If it is high in a tree, a gradual approach starting at the time of darting and shortening the distance between worker and lion as the animal reaches various stages of anesthesia is best. Invariably, some cats will jump the tree when hit with the dart or at some point before being fully anesthetized.

Lower the animal by a leg, either front or rear. A slip knot or lariat noose over a hock joint will work. Lowering by the neck is possible, but must be done quickly if survival of the animal is important. Even when lowering an animal by the legs, extended hanging should be avoided.

When Sernylan is used, 3-4 hours are available for handling the lion before recovery. Ketoset (*Ketamine*) may last less than an hour. A Rompun-Ketoset mixture (1ml Rompun: 100 ml ketoset) extends the duration of anesthesia with Ketoset.

Lions are generally easy to handle with the proper drugs. Overdose with either Sernylan or Ketoset is not likely. Excess drug will produce a shorter reaction time and longer recovery time. Overdoses of as much as 100

percent with Sernalyn will usually not be fatal. In situations where human crowds are present, overdose may be a good option. The greatest danger probably lies in the animal falling from a tree before it can be reached with ropes. If limbs are fairly dense as in most conifers, a drop of 20-30 feet will usually not damage the animal. We have, at times, intentionally administered half-doses of Sernalyn, then backed off to allow the lion to descend, stretching it with a rope around the neck and a grip on the tail when it hits the ground. A light additional dose of 10-15 mg of drug will produce the necessary remaining anesthesia.

HANDLING DEPREDATION PROBLEMS

The Arizona Game and Fish Department, at the time of this writing, is not actively engaged in depredations control work in any manner. What the future holds along these lines is uncertain. At present, the stock-killer clause in Arizona statutes (A.R.S. 17-302, A-D) allows ranchers to take any means necessary to solve the problems themselves. This may involve trapping the lion, hiring a local hunter, or seeking help from the U.S. Fish and Wildlife Service.

Arizona's stock-killer clause was written more or less on the theory that removal of a few offending individual lions would solve the depredations problem. In the case of lion attacks on sheep bedgrounds, this may be true. Usually, taking one or two lions in the area where the depredation is occurring will solve the problem for at least one season. Where cow-calf operations are suffering losses the problem is different. On the Spider Ranch in Arizona, essentially all mature lions on the area were eating beef at least part of the time.

Under such circumstances actual reduction in lion numbers may be the only solution. Much, however, remains to be learned regarding the real effects of lion control. Some indirect evidence suggests that under moderate removal rates, established adult residents may be replaced by subdominant lions as home areas become vacant. While they are vying for a territory, several subdominants may occupy the territory of one established lion. Whether or not these subdominants tend to take more of the easily caught domestic species is unknown. Much more information is needed regard-

ing the forms of replacement, population structure, and predation patterns of exploited lion populations.

Our limited experience indicates that moving problem lions is not a viable solution. The two lions we transported from their home aras both turned up 20-50 miles from the points we released them. Both had killed livestock at their second capture sites. California has had similar experiences with transplanted cats.

At present, the best lion management tool available to the area manager in Arizona is sport hunting. Close involvement with the good dog man in a district can serve two functions. It can help keep closer tabs on lion removal from a district, and also help to direct the sporting effort into problem areas.

CHECK LIST FOR SUSPECTED PREDATOR KILL

Date Inspected: _____ How Located: found by AGF personnel, reported by rancher, forester, hunter, other? Note which.

Species: _____

Location _____

Estimated time since death _____

Kill site description:

Slope direction _____ Percent _____

Cover vegetation type _____

Tree or shrub species where kill is stashed _____

_____

General Appearance:

Drag marks present _____ How far dragged _____

Predator tracks present? Species _____ Msmts _____

Kill covered _____ Type of debris _____

Has kill been moved _____ How many times _____

No. of burial sites _____

Carcass characteristics

Carcass fed upon _____

Percent consumed _____

Position of carcass. On side, extended, curled up, Other _____

Apparent point of first feeding on carcass: rib cage, hind quarters, front quarters, other (describe) _____

_____

Use of entrails: parts missing, parts present, percent of entrails consumed _____

Use of muscle and fat: hind quarters, front quarters, neck etc. Percent of each portion _____

_____

Signs of predator damage on carcass:

Tooth marks – location _____

Msmts (*distance between canines)* _____

Claw marks – location _____

Blood on ground or carcass; describe _____

_____

Signs of subcutaneous or internal hemmorrhage; location and description _____

_____

Probable means of killing:

Broken neck or vertebrae _____

choked _____ other, describe _____

_____

Signs of struggle or chase at kill site _____

Investigation assessment of predator involvement:

Certain _____, unlikely _____, highly probable _____,

predator not cause of death _____, possible _____

Condition of prey prior to death:

Sex _____ Age _____ Antlers or horns present _____

Unborn young present _____ Lactating _____

Fat present on: intestines, liver, kidneys, heart, saddle, hips, ribs, brisket. Note parts not available for examination. _____

_____

Femur marrow: solid _____ gelatinous _____

Color: red, yellow, white, spotted pink, dark pink

Parasites present: ticks, heavy _____ light _____

nose bots _____, other parasites: _____

_____

Evidence of old injuries or disease:

Color of lungs, if present: light pink, deep red, dark red or purple. _____

Notes:

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LION MANUAL

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